

BROOMED TREES



The dense misshapen branches of witches' brooms sometimes found in conifers, provide unique wildlife habitat in interior Columbia River basin forests. Brooming is most often caused by the dwarf mistletoes (*Arceuthobium* spp.), rust fungi (*Chrysomyxa* spp. or *Melampsorella* spp.), or a needle cast fungus (*Elytroderma deformans*). These three groups of organisms will be discussed separately.

Dwarf Mistletoes

Ecological processes and functions—Dwarf mistletoes are perennial parasitic plants that derive water and nutrition from their hosts (figs. 21-26). Most dwarf mistletoes are host-specific, but trees of all ages can be infected. Dwarf mistletoes typically produce spindle-shaped branch swellings at the point of infection. A few years after infection, dwarf mistletoes produce distinctive shoots on swollen branches that become witches' brooms after several years. Over many years, infection will increase on individual trees and within stands. Heavily infected trees grow more slowly in diameter and height than do lightly infected or uninfected trees. Heavily infected trees produce fewer cones and seeds and often develop spike tops. Eventually, heavily infected trees

die. The most commonly affected tree species in interior Columbia River basin forests are Douglas-fir, lodgepole pine, ponderosa pine, and western larch (Hawksworth and Wiens 1996).

Trees infected with dwarf mistletoes can be directly or indirectly beneficial to wildlife. Wildlife species consume mistletoe shoots and fruits, forage for insects in mistletoe plants and brooms, and use witches' brooms for cover and as nesting sites (Hawksworth and Wiens 1996, Mathiasen 1996). Dwarf mistletoes cause openings and changes in stand structure by killing trees (Nicholls and others 1984).

The shape, size, and position in the tree of dwarf mistletoe brooms differ considerably and influence their potential wildlife use. The characteristic shape and size of brooms depend on where and how they form along the bole. Three types of brooms are recognized (Tinnin and Knutson 1982, 1985).

Brooms that form platforms are best suited to raptors for nesting. Brooms are habitual nest sites for northern spotted owls (*Strix occidentalis*) (Forsman and others 1984, Martin and others 1992), long-eared owls (*Asio otus*) (Bull and others 1989), goshawks (*Accipiter gentilis*), and Cooper's



Figure 21—Douglas-fir dwarf mistletoe may form large, drooping brooms. Brooms are generally more abundant in the lower crown.



Figure 22—The aerial shoots of Douglas-fir dwarf mistletoe are smaller than the host needles (0.5 to 0.75 inches) and may not always be present on broom branches.

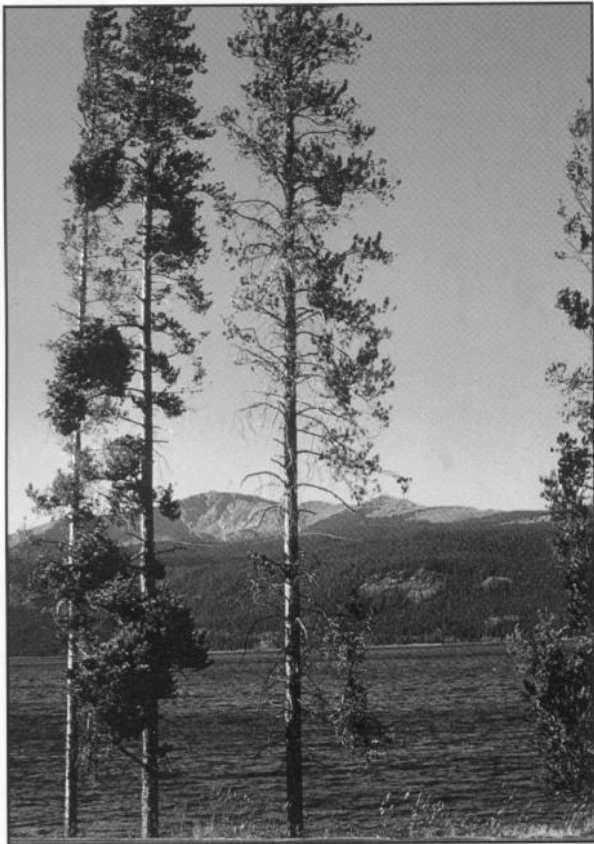


Figure 23—Dwarf mistletoe brooms on lodgepole pine.



Figure 24—Open brooms and distorted branching caused by dwarf mistletoe on ponderosa pine.

Photo by Craig Schmitt



Photo by Craig Schmitt

Figure 25—Aerial shoots of dwarf mistletoe often are present on infected ponderosa pine.

hawks (*Accipiter cooperii*) (Reynolds and others 1982). Some song birds also nest in witches' brooms (Hawksworth and Wiens 1996).

Long-eared owls nest on platforms of Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) brooms that average 14 by 19 inches in diameter, with an average depth of 9 inches (Bull and others 1989). Douglas-fir brooms used by great horned (*Bubo virginianus*) and great gray owls (*Strix nebulosa*) exceed 3 feet in diameter (Bull 1996b). Brooms selected by northern spotted owls are usually the larger and denser brooms located away from the stand edge (Martin and others 1992). The specific structural characteristics of brooms associated with nests of other wildlife species have not been documented and warrant further investigation.

Witches' brooms caused by Douglas-fir dwarf mistletoe commonly are used by blue grouse (*Dendragapus obscurus*) for roosting cover (Martinka 1972, Stauffer and Peterson 1986), and they eat mistletoe seeds (Seversen 1986).

The shoots of ponderosa pine dwarf mistletoe (*A. campylopodum*) are an important fall and winter food for porcupines (*Erethizon dorsatum*) (Hooven 1971, Lawrence 1957). Chipmunks (*Tamias* spp.) commonly eat mistletoe seeds (Broadbooks 1958, Nicholls and others 1984). Squirrels and porcupines feed selectively on mistletoe-infected twigs in preference to uninfected twigs (Johnson and Carey 1979, Wood and others 1985) and use the brooms as winter resting cover (Smith 1982). American martens use brooms in lodgepole pine (Burnett 1981, Buskirk and others 1987,



Figure 26—Western larch with dwarf mistletoe brooms provide good nesting platforms that raptors use.

Campbell 1979, Spencer 1987), Douglas-fir, and western larch (Bull 1995) for resting sites.

Although these plants have a high nutritive value (Urness 1969), they are usually too high in the trees to be accessible to deer and elk, which eat shoots that fall to the ground, however. Mistletoe shoots are a regular component in mule deer diets (Leach and Hiele 1957, Wright and Arrington 1950) and can provide a high-protein winter food for elk (Craighead and others 1973). Clary and Larson (1971) found that in certain years, ponderosa pine stands with dwarf mistletoe sheltered significantly more deer than stands without dwarf mistletoe.

Dwarf mistletoes are a natural part of the Northwest forest ecosystems; they have coevolved with their hosts for millions of years (Hawksworth and Wiens 1996). Dwarf mistletoes should be valued and recognized as a functional and beneficial wildlife resource. Bennetts and others (1996) found a direct positive correlation among the intensity of dwarf mistletoe and the diversity and total number of birds in ponderosa pine stands. They also demonstrated a positive correlation between numbers of snags and intensity of dwarf mistletoe infection. Nearly three times as many cavity-nesting birds were found in heavily infested stands as in comparable uninfested stands.

Infection process—Dwarf mistletoes spread from tree to tree by way of an explosive fruit mechanism. Fruits produced on female plants contain one seed that is forcibly expelled during late summer or fall. Seeds are coated with a

sticky substance that allows them to adhere to objects they strike. Seeds that land on susceptible trees can cause new infections. Seeds usually land within 20 feet from their origin, as a consequence, the spread of dwarf mistletoes is relatively slow (only 1 to 2 feet per year). Spread from tree to tree and spread in individual trees is more rapid in forests with multistoried structures (Parmeter 1978).

Birds and mammals can pick up the sticky seeds on their bodies and transport them to new infection sites (Hawskworth and others 1987, Lemons 1978). Spreading by birds is considered important in introducing initial infection into uninfected stands.

Because dwarf mistletoes only grow and reproduce on living trees, any ecological process or management option that kills the host will eliminate dwarf mistletoes. Wildfire is believed to have historically kept populations of dwarf mistletoe in check (Alexander and Hawskworth 1975). The dwarf mistletoe population is reduced immediately after a burn, but as a new stand develops, dwarf mistletoe populations increase from seeds cast down from surviving trees. These overstory trees infect the developing young trees, or mistletoe is reintroduced into the new stand from adjoining infested stands.

Management implications—Managing stands to retain mistletoe-infected trees has both benefits and drawbacks. Careful selection of infected trees will benefit wildlife; however, heavy mistletoe infection of a stand may adversely affect some wildlife. Trees that are heavily infected produce fewer, smaller cones of poorer quality (Hawskworth and Shaw 1984). This reduction in cones can affect both tree regeneration and cone-feeding wildlife. Although small patches of dead trees provide diversity, extensive tree mortality may cause loss of canopy cover that protects wildlife from extreme weather and predation.

Martinka (1972) found heavy use by blue grouse in the most severely infested Douglas-fir stands. He suggests curtailing the thinning of overstocked stands and destroying infected Douglas-fir in areas important for blue grouse breeding. These thickets are often in areas where the trees are ill-adapted to the site. To assure that adequate wildlife habitat is maintained in managed forests, mistletoe-infected portions of stands identified as being important for blue grouse breeding and resting should be retained.

Reynolds and others (1992) suggest that although brooms are beneficial as nesting habitat for goshawks, changes in stand structure caused by dwarf mistletoes can be detrimental to some goshawk prey species. For example, ponderosa pine stands heavily infested with southwestern dwarf mistletoe (*A. vaginatum* subsp. *cryptopodum*) become stagnated and may not develop beyond the young-forest stage or may revert, because of high mortality, to the grass-forb-shrub stage. Management recommendations for developing the desired forest conditions could include thinnings, with removal of trees with brooms high in the crown to reduce the detrimental effects of mistletoe in the goshawk postfledgling family and foraging areas. Selecting reserve trees free of, or only lightly infected with, dwarf mistletoe may be desirable.

High dwarf mistletoe populations may put the stand at

risk to stand-replacing wildfire. Dwarf mistletoes were restricted by fire in pre-European forests; frequent fires were the rule in the drier communities, where dwarf mistletoe is most prevalent (Hessburg and others 1994). Fire tended to reduce infection of mistletoe in stands by removing a higher proportion of trees with heavy infection (Alexander and Hawskworth 1975). Low-hanging brooms and broken brooms around the bases of infected trees allowed higher burning temperatures and greater flame lengths (Wicker and Leaphart 1974), thereby making the stand more susceptible to crown fire. Stands recently invaded by Douglas-fir after fire exclusion may have a steadily increasing risk of crown fires where infection centers develop.

Although dwarf mistletoes are a native component of the interior Columbia River basin forests, the effects that these parasites have on tree growth and survival is an important forest management issue, not only for timber production, but also for wildlife and other resources. Because they are obligate parasites, dwarf mistletoes can be effectively reduced to meet management objectives by using silvicultural treatments that emphasize the removal of infected trees.

Selecting trees—When selecting infected tree species for wildlife use, we believe that choosing groups of lightly infected trees, where the brooms appear large and dense enough to furnish a nesting platform, will provide the most benefits to wildlife. Infected trees left in groups rather than as individual trees throughout the stand can be effectively isolated from the rest of the stand by maintaining a buffer of nonhosts or an unstacked area. The buffer or unstacked area needed to limit spread into the stand is 30 feet for mistletoe-infected Douglas-fir and 100 feet for infected ponderosa pine (Scott and Schmitt 1996).

Reserving older, infected western larch may be critically important in some stands to provide nest platforms for raptors and long-lasting, high-quality cavity-nester habitat. When selecting overstory western larch as wildlife trees, select those trees most heavily affected by mistletoe and with obvious platforms. Most mistletoe-caused larch mortality is the result of heavy infestations that lead to progressive loss of broomed branches and degradation of the whole crown. Such trees are most likely to produce a high-quality snag, but the infection potential is low because the diminutive crown supports fewer mistletoe plants. If management of under-story western larch is an objective, leaving wildlife trees that will produce the fewest mistletoe seeds to infect the under-story would be best. Lightly infected larch have been traditionally left as “crop” or “seed-trees,” but they could produce more dwarf mistletoe seeds because of their larger, more vigorous crowns.

When selecting infected tree species other than western larch for wildlife use, leaving a patch of trees that contains some trees with brooms in the mid-crown that are large and dense enough to furnish a nesting platform will provide the most benefit. These trees will have a moderate infection rating and will be growing slower than uninfected trees, but they provide good habitat. Trees with brooms in the top third of the crown can be removed to improve stand productivity with limited loss to wildlife.

Broom Rusts

Ecological processes and functions--Like dwarf mistletoes, broom rusts cause witches' brooms on their coniferous hosts. Unlike dwarf mistletoes, which are parasitic plants, broom rusts are pathogenic fungi. These fungi require an alternate herbaceous host for completion of their life cycle but can spread in primary host branches without further infection (Ziller 1974).

Little information is published on wildlife uses of brooms caused by broom rusts. American martens in northeastern Oregon commonly use rust brooms for rest sites (fig. 27) (Bull 1995). Thirty-four of 56 flying squirrel dens were in rust brooms in interior Alaska (Mowrey and Zasada 1984). Frank Hawksworth speculated that several reports of wildlife use of mistletoe witches' brooms documented by wildlife biologists are actually rust brooms. This speculation is based on the reports of unlikely hosts for dwarf mistletoes or geographical locations out of range for a particular host-mistletoe relation (Hawksworth 1992). Nonetheless, rust brooms probably serve the same functions as dwarf mistletoe brooms. Broom rusts are not as prevalent in interior Columbia River basin forests as dwarf mistletoes are, and because of differences in infection biology, care should be taken to differentiate them from dwarf mistletoes in selecting wildlife trees.

Infection process--Spruce broom rust (*Chrysomyxa actosathyli*) infects Engelmann spruce (figs. 28 and 29). The herbaceous alternate host is kinnikinnick (*Arctostaphylos uva-ursi*). Fir broom rust (*Melampsorella caryophyllacearum*) infects grand and subalpine firs. The herbaceous alternate hosts are chickweeds (*Stellaria* spp. and *Cerastium* spp.). The conspicuous orange-yellow brooms on their coniferous hosts are apparent, especially in the summer when affected needles are covered with blisters filled with yellow or orange spores. The discolored needles are cast in fall, and a new flush of needles appears the next spring. Brooms grow perennially and may be older than 30 years. Broom rusts often are associated with spiketops, dead branches, stem deformities, and breakage, but host mortality is rare.

Selecting trees--Because of the difference in the infection process, retention of trees with broom rusts does not have the potential negative management implications associated with unlimited retention of dwarf mistletoes. Trees with the largest brooms are immediately suitable for wildlife use. Because small brooms often will continue to grow, trees with all sizes of brooms may be retained for future use. Retaining infected trees is advisable whenever possible because broom rusts are uncommon.

Elytroderma Disease

Ecological processes and functions--Elytroderma disease of pines is caused by the needle cast fungus *Elytroderma deformans*. It is most prominent in ponderosa pine in the interior Columbia River basin but is occasionally found on lodgepole pine (Childs and others 1971). Heavily infected trees are defoliated because of "cast" or dropping of infected needles. Brooms formed by this fungus (fig. 30) can resemble the brooms formed by dwarf mistletoes.

Little wildlife use of brooms formed by Elytroderma has been documented, because the brooms are not commonly distinguished from those formed by dwarf mistletoes. Great horned owls have been observed nesting in Elytroderma brooms (Bull 1996b) (fig. 31). Presumably, other raptors that nest in brooms formed by dwarf mistletoes also would nest in brooms formed by this fungus.

Infection process--Spores of the causal fungus are released in late spring and early summer from tiny fruiting bodies borne on infected needles (fig. 32). Under conditions of rain or free moisture, the airborne spores germinate and infect the young needles of a susceptible host. The fungus spreads throughout the needles and into the twigs. The infection within the twigs spreads into the growing tips and buds, where it causes brooming and deforms future growth. Needles infected the previous year are cast after turning bright red and then fading to straw color. Severe infection will produce thin, ragged crowns and growth reduction of the tree. Tree mortality occasionally results from heavy defoliation. Light infection of 25 percent or less of the crown causes little reduction in tree growth or survival.

Selecting trees--In ponderosa pine, Elytroderma brooms may be distinguished from mistletoe brooms by the presence of fruiting bodies on the needles of the broom, by the accumulation of dead needles in the broom structure, and by the absence of the dwarf mistletoe plants usually associated with dwarf mistletoe-caused brooms. Infected needles lose their bright red-brown color gradually through summer in Elytroderma brooms. The brooms tend to be more compact and spherical than those caused by dwarf mistletoes, and the ends of twigs turn up.

Management implications--When selecting broomed trees in stands for retention where ponderosa pine regeneration is a management objective, selecting Elytroderma-infected trees may be preferable to selecting dwarf mistletoe-infected trees, when they are available. Elytroderma may be less debilitating to the host tree, and its dense brooms may sometimes be more valuable to wildlife than are the more open brooms of dwarf mistletoes. When Elytroderma-infected trees are available, select trees that have 25 percent or less crown infection.

Review

- Brooms serve as food and hiding and nesting habitat for both invertebrates and vertebrates. Brooming is most often caused by dwarf mistletoes, rust fungi, or Elytroderma disease.
- Dwarfmistletoe brooms are most useful to some wildlife if they form a platform, although the shoots and seeds of the dwarf mistletoe plant also are eaten by wildlife.
- Dwarf mistletoes can spread to the point that they adversely affect wildlife habitat by limiting tree growth, causing extensive tree mortality, and increasing risk of crown fire. To limit spread, dwarf mistletoe-infected trees reserved for wildlife can be grouped and surrounded by a buffer of trees that are nonhosts or by a treeless buffer. Buffers slow the spread into the surrounding stand.
- Brooms caused by rusts offer useful nesting and resting habitat. These brooms are most commonly found on Engelmann spruce and subalpine fir.
- Reserving trees with brooms caused by rusts or Elytroderma disease may provide broom habitat without the same concerns of spread associated with reserving dwarf mistletoe-infected trees.

